ECE 461/661 - Test #2: Name ____________________

Feedback and Root Locus - Fall 2025

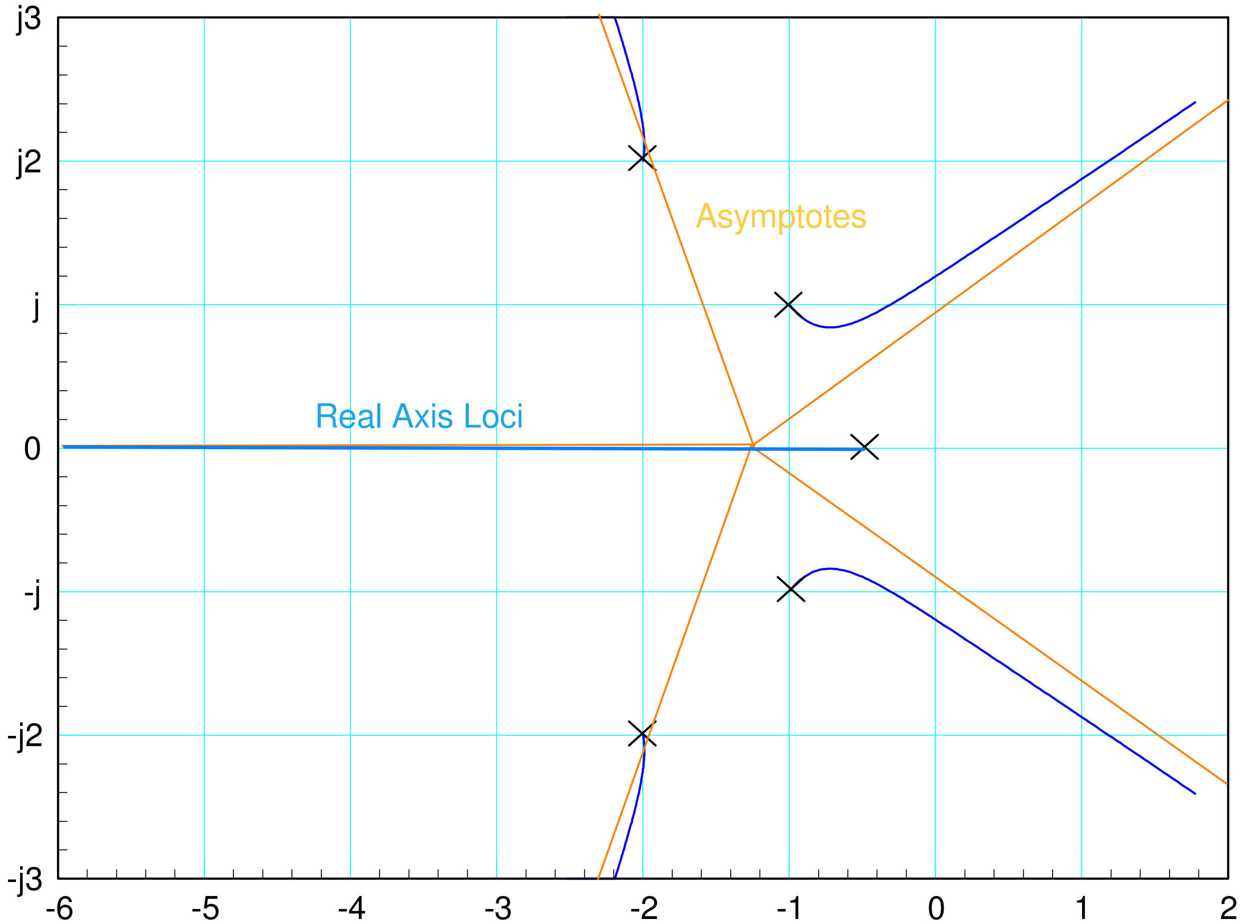
Root Locus

1) The root locus of G(s) is shown below.

$$G(s) = \left(\frac{10}{(s+0.5)(s+1+j)(s+1-j)(s+2+j2)(s+2-j2)} \right)$$

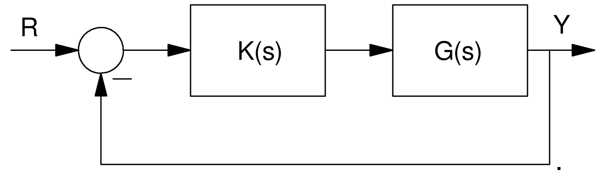
Determine the following

Departure Angle from the pole at -2+j2	Departure Angle from the pole at -1+j1	Real Axis Loci
79.69 degrees	-53.13 degrees	(-0.5, -infinity)
Breakaway Points (approx)	**Asymptotes**	**jw Crossing(s)**
none	show on graph	j1.1962



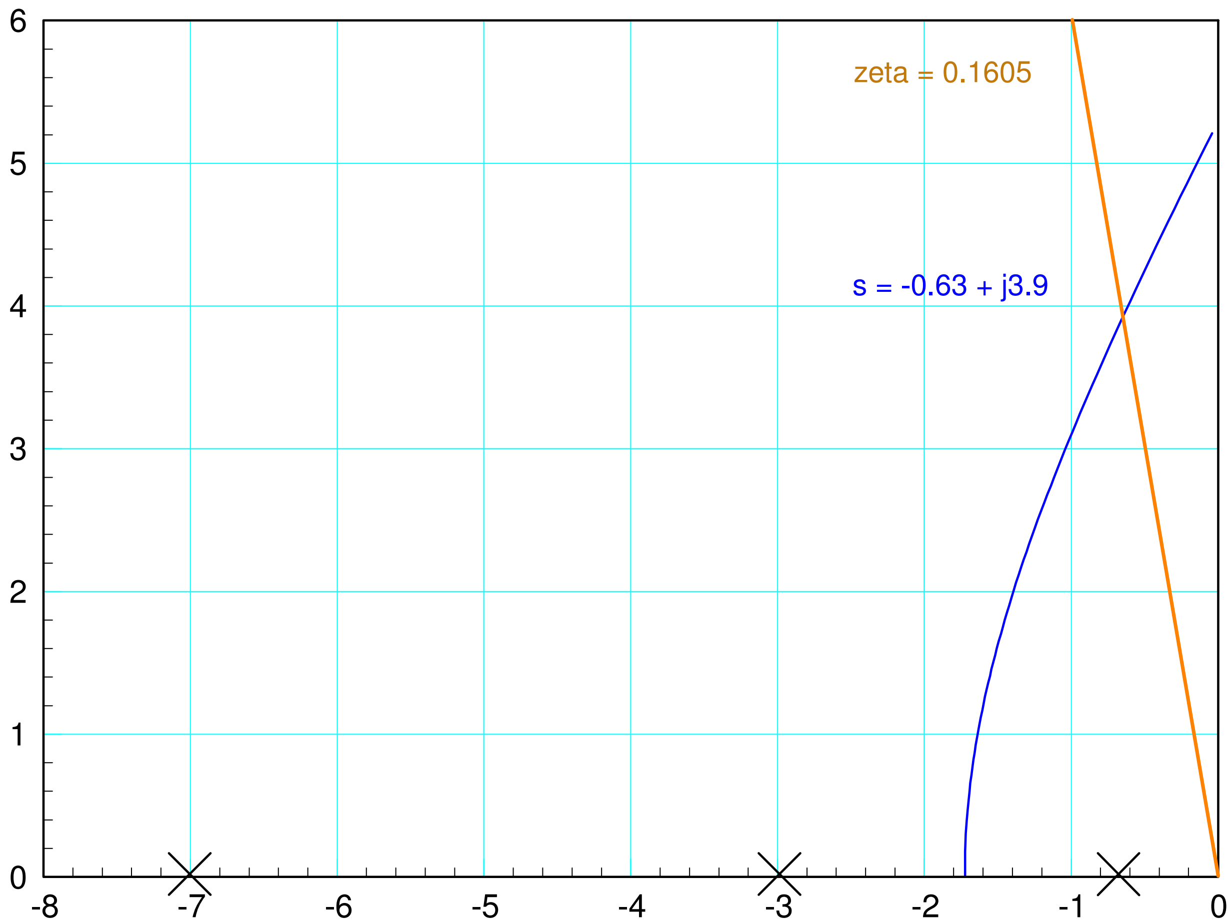
Gain Compensation

2) Determine the gain $(K(s) = k)$ so that the feedback system has 60% overshoot for a step input. Also determine the closed-loop dominant pole(s) and error constant, Kp

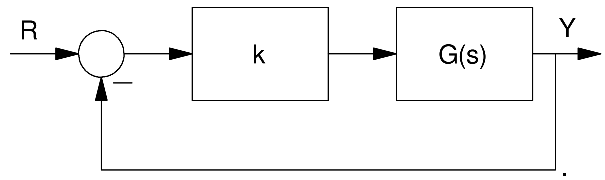


$$G(s) = \left(\frac{10}{(s+0.7)(s+3)(s+7)}\right)$$

Damping Ratio 60% overshoot	Angle of Pole	k 60% overshoot	Closed Loop Dominant Pole(s)	Kp Error Constant
0.1605	80.76 deg	13.53	s = -0.6408 + j3.9393	9.2054 13.53 * 0.6803



Lead/PI Compensation



3) Design a compensator, K(s), so that the closed-loop system has

- No error for a step input
- Closed-Loop dominant poles at s = -3 + j2, and
- Finite gain as $s \to \infty$ (i.e. have at least as many poles as zeros)

$$G(s) = \left(\frac{10}{(s+0.7)(s+3)(s+7)}\right)$$

Let

$$K(s) = \left(\frac{k(s+0.7)(s+3)}{s(s+a)}\right)$$

$$GK = \left(\frac{10k}{s(s+7)(s+a)}\right)$$

Evaluate what we know at the design point

$$\left(\frac{10}{s(s+7)}\right)_{s=-3+j2} = 0.6202\angle -172.875^0$$

To make the angle 180 degrees

$$\angle(s+a) = 7.125^0$$

$$a = \left(\frac{2}{\tan\left(7.125^0\right)}\right) + 3 = 19.0($$

Now evaluate what we know

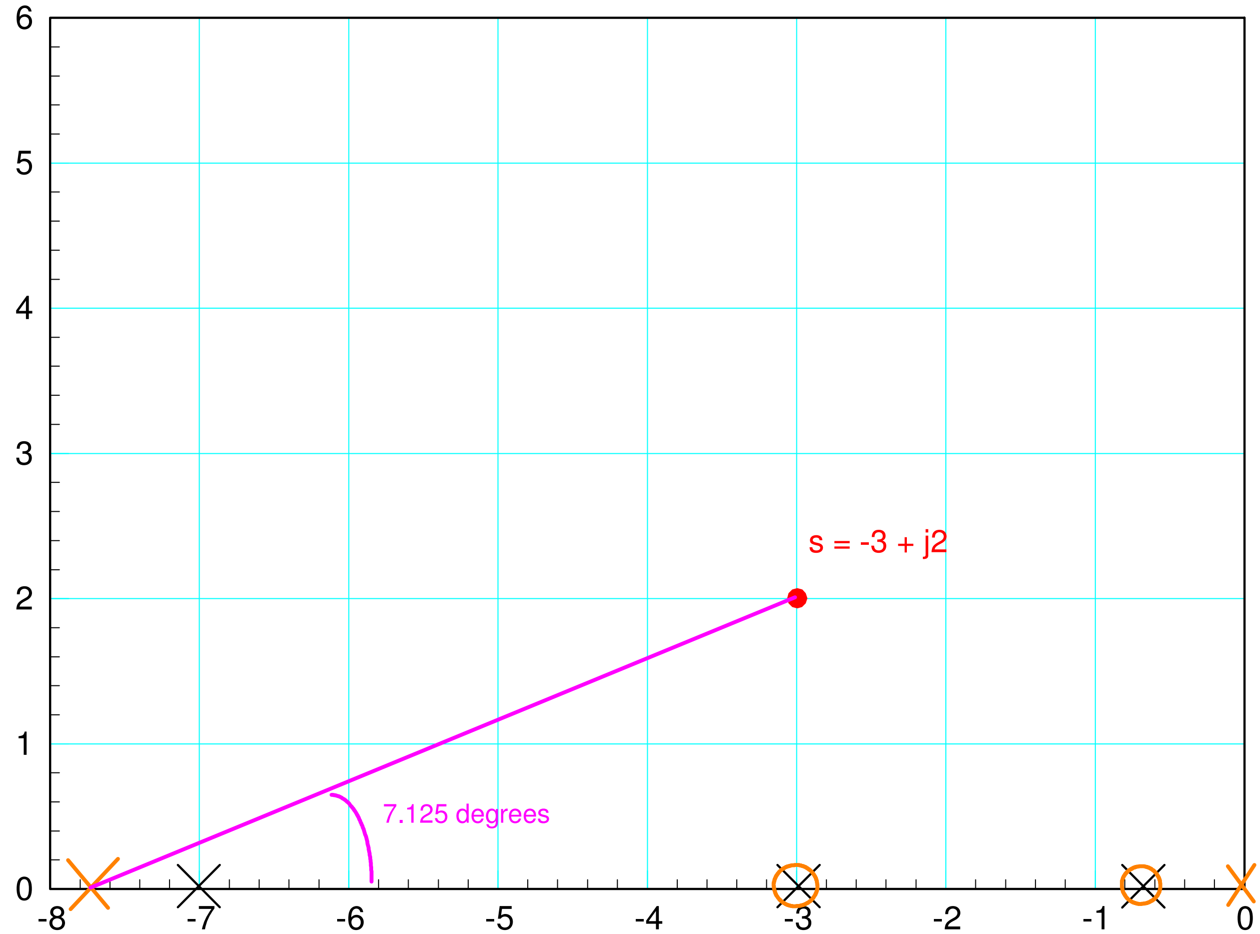
$$\left(\frac{10}{s(s+7)(s+19)}\right)_{s=-3+j2} = 0.0385\angle 180^0$$

k is then

$$k = \frac{1}{0.0385} = 26.00$$

and

$$\boxed{K(s) = \left(\frac{26(s+0.7)(s+3)}{s(s+26)}\right)}$$



s = -3 + j2
7.125 degrees
6
5
4
3
2
1
0
-8
-7
-6
-5
-4
-3
-2
-1
0

Compensator Design (hardware)

4) Design a circuit to implement K(s)

$$K(s) = \left(\frac{25(s+3)(s+7)}{s(s+10)}\right)$$

Rewrite as

$$5\left(\frac{s+3}{s+10}\right) \cdot 5\left(\frac{s+7}{s}\right)$$